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**Pacific Northwest  
National Laboratory**

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# **High-Level Waste Tank Lay-Up Assessment Year-End Progress Report**

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September 26, 2001

\* Jacobs Engineering Group, Inc.



Prepared for the U.S. Department of Energy  
under Contract DE-AC06-76RL01830

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Pacific Northwest National Laboratory  
Richland, Washington 99352

## CONTENTS

1.0	INTRODUCTION .....	1
2.0	BACKGROUND .....	1
2.1	TANK LAY-UP NEEDS AT SITES .....	2
2.2	HANFORD SITE.....	5
2.3	SAVANNAH RIVER SITE.....	5
2.4	IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY .....	5
2.5	OAK RIDGE RESERVATION .....	6
3.0	PRELIMINARY NEEDS ASSESSMENT RESULTS .....	6
3.1	HANFORD SITE.....	6
3.2	SAVANNAH RIVER SITE.....	9
3.3	IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY .....	9
3.4	OAK RIDGE RESERVATION .....	9
4.0	RECOMMENDATIONS .....	9
5.0	REFERENCES .....	10
6.0	BIBLIOGRAPHY .....	12

## TABLES

1.	Comparison of Site High-Level Waste Tank Programs .....	3
2.	Site High-Level Waste Lay-Up Requirements and Considerations .....	7

## **LIST OF TERMS**

DOE	U.S. Department of Energy
EIS	environmental impact statement
FY	fiscal year
HLW	high-level waste
INEEL	Idaho National Engineering and Environmental Laboratory
ORR	Oak Ridge Reservation
SRS	Savannah River Site
WVDP	West Valley Demonstration Project

## **1.0 INTRODUCTION**

This report documents the preliminary needs assessment of high-level waste (HLW) tank lay-up requirements and considerations for the Hanford Site, Idaho National Engineering and Environmental Laboratory (INEEL), Savannah River Site (SRS), and Oak Ridge Reservation (ORR). This assessment includes the development of a high-level requirements and considerations list that evolved from work done for the West Valley Demonstration Project (WVDP) earlier in fiscal year (FY) 2001, and is based on individual site conditions and tank retrieval/tank closure schedules. Because schedules are continually subject to change, this assessment is considered preliminary and needs review and validation by the individual sites. The lay-up decision methodology developed for WVDP was based on standard systems engineering principles, and provided a structured framework for producing an effective, technically-defensible lay-up strategy.

On September 6, 2001, the results from the WVDP work were briefed to the Tank Focus Area Strategic Initiatives Review Board along with recommended follow-on work in FY 2002. Based on the verbal feedback during that meeting, there appear to be two potential paths for follow-on work. The first would be developing a tank lay-up informational database. This would include compiling a bibliography of documents from across the U.S. Department of Energy (DOE) complex concerning subjects of potential interest to lay-up, such as residual waste characterization and stabilization, tank integrity evaluation, surface and subsurface barrier installation and evaluation, high-performance cleanout methods and leak detection technologies, and techniques to reduce tank surveillance, monitoring, and maintenance. The second path would be the development of detailed lay-up requirements and considerations for one tank at one site. This would include developing cost estimates for continued operation of the tank under existing site requirements and the costs for lay-up of that one tank. This evaluation would provide a programmatic baseline for tank lay-up which could be of value to all sites. These two paths are not necessarily mutually exclusive. This task is currently awaiting the recommendations of the Review Board.

Background information is provided on each of the sites, including a comparison of the tank management programs. Finally, recommendations for follow-on work are provided.

## **2.0 BACKGROUND**

HLW tanks were constructed and operated at a number of DOE sites to store waste that was mainly generated from the reprocessing of spent nuclear fuel. The initial step in remediating tank waste involves the retrieval and treatment of the tank waste for disposal. The second step involves dispositioning the tank facilities. Plans have been developed and are in various stages of implementation across the complex for the retrieval and treatment of the waste contained in the tanks and the tanks. Plans are less defined for how the tanks will be managed following retrieval and how they will be closed.

Each HLW tank in the DOE complex must transition from completion of its operational life to final closure, and depending on the uncertainty in the closure requirements or the uncertainty with closure decision making, the time this may take varies greatly. Technical, programmatic, and/or regulatory issues may make this tank transition management period last for years or even decades. Prudent tank closure planning accomplishes the following:

- Recognizes the potentially extended closure period
- Identifies objectives, requirements, and considerations
- Considers interim, pre-closure actions to place the tank and any residual contents into a safe, stable, and minimum maintenance condition without compromising final closure options.

The interim condition is referred to as tank lay-up. Tank lay-up recognizes that this period of time is different than normal tank operations, and this difference warrants evaluation of the requirements for configuring, operating, and maintaining the tanks during the transition from waste storage to closure. Tank lay-up is the bridge between the waste storage phase and closure phase in the life cycle of a tank.

The complexity and extent of tank lay-up actions will likely vary depending on the following:

- Lay-up period
- Tank's operating history and physical condition
- Current understanding of closure requirements
- Perceived risks of any residual waste.

One of the first actions in managing tank transition is the development of requirements and considerations for tank lay-up. Sites whose current schedules reflect relatively short transition periods may foresee few or no lay-up needs. Sites with relatively long transition periods may execute extensive lay-up plans, to minimize surveillance/monitoring costs and show progress toward closure.

## **2.1 TANK LAY-UP NEEDS AT SITES**

Tank lay-up needs are a function of a number of different variables. The need for, and potential benefits from, tank lay-up depend on the number and physical condition of the tanks, the potential lay up period, the uncertainty in tank closure requirements, the risks associated with the waste heel, and the regulatory environment.

The intent of the lay-up period is to reevaluate the requirements and consider what is known about the tank, tank farm, and future tank closure criteria. The decision process developed for WVDP provides a means to weight the requirements and considerations based on individual site conditions and considerations.

Table 1 is a comparison of the tank programs at the various sites. WVDP is included for completeness. An evaluation of that site's tank lay-up requirements and considerations has been previously reported (Henderson, 2001a, b, c, and d).

The Hanford Site and SRS have 80% of the total HLW tanks to be closed, more than 95% of the HLW requiring retrieval and disposal, and all of the known and assumed leaking tanks. Because of the current uncertainties in these cleanup and closure programs, they may also have the greatest potential need for tank lay-up planning.

**Table 1. Comparison of Site High-Level Waste Tank Programs (2 Sheets)**

	<b>WVDP</b>	<b>Hanford Site</b>	<b>SRS</b>	<b>INEEL</b>	<b>ORR</b>
Number of tanks/areas to close	4/1 area	177/18 tank farms	51/2 tank farms	11 <sup>a</sup> /1 tank farm	40/5 tank farms
Tank types	2	2	4	2	6
Tank sizes, 10 <sup>3</sup> gal	15-750	55-1,160	750-1,300	318	1.5-170
Tank ages, years	35	15-58	20-50	37-50	3-58
Tank conditions	No leakers	67 confirmed and assumed leakers	11 leakers	No leakers	No leakers
Waste types	Alkaline	Viscous, alkaline liquid, sludge, salt cake	Viscous, alkaline liquid, sludge, salt cake	Acidic, liquid sodium waste, sludges; calcined powder	Liquids, sludges
Waste volumes, 10 <sup>6</sup> gal	0.6	54	33	1.4	0.4
Waste radionuclides, 10 <sup>6</sup> Ci	0.03	200	470	0.52	0.047
Retrieval schedule	Tank heels cleaned out in 2001 to Class C limits	SSTs complete by 2018 <sup>b</sup> and DSTs by 2028 <sup>b</sup>	2019 for Type I, II, and IV; 2024 for Type III	HLW complete 1998; remaining liquid waste by 2012	90% of inactive tanks complete. Remainder as mission is completed
Closure schedule	Not yet finalized; closure expected to take up to 20 years	SSTs by 2024 <sup>b</sup> and DSTs by 2032 <sup>b</sup>	2022 for Type I, II, and IV; Type III by 2030	In six phases from 2005 to 2016	24 tanks without secondary containment by 2022; others as storage mission is completed
Tank maximum ages in years at closure	More than 50	More than 75	More than 75	More than 60	More than 70
Approved final closure requirements	No	No	Some top-level developed	Some top-level developed	No



**Table 1. Comparison of Site High-Level Waste Tank Programs (2 Sheets)**

	<b>WVDP</b>	<b>Hanford Site</b>	<b>SRS</b>	<b>INEEL</b>	<b>ORR</b>
Closure regulatory drivers	DOE/EIS-0226-D; NYSERDA 1980; WVDP Acts of 1980 & 1991	DOE/EIS-0189; DOE/EIS-0222F; Ecology et al. 1989; MOU 1996	DOE/EIS-0217; DOE/EIS-0303D; Site Treatment Plan; Supplemental EIS; Wastewater Closure Plan; WSRC-OS-94-42	DOE/EIS-0287D; DOE-ID 1991; Settlement Agreement	Accelerated Cleanup Plan; DOE/OR-1014; ORR Order
Site and tank specific considerations and uncertainties	Corrosion, in-tank hardware; water in vaults	In-tank hardware; arid climate; well above water table; contaminated vadose zone/groundwater	In-tank hardware; some tanks in water table; 2 tanks interim closed in 1997	Tanks are stainless steel; in-tank hardware; seismic; no secondary containment	Waste not classified as high-level; in-tank chunks of gunite

<sup>a</sup>Plus an additional 7 calcine bin sets, containing 3.8 million L (24 million Ci) of calcined HLW, and four 30,000 gal stainless tanks in the tank farm facility.

<sup>b</sup>Currently reevaluating to extend dates.

DST = double-shell tank.

EIS = environmental impact statement.

FFCA = Federal Facility Compliance Agreement.

HLW = high-level waste.

INEEL = Idaho National Engineering and Environmental Laboratory.

MOU = memorandum of understanding.

ORR = Oak Ridge Reservation.

SRS = Savannah River Site.

SST = single-shell tank.

WVDP = West Valley Demonstration Project.

## **2.2 HANFORD SITE**

Nearly two-thirds of all DOE HLW tanks and tank waste, and 85% of all confirmed and assumed leaking tanks are located at the Hanford Site. Many of the tanks are inactive and essentially empty. Waste retrieval projects are planned that would empty additional tanks over the next few years. An environmental impact statement (EIS) for retrieval and treatment of the tank waste has been issued, but tank closure requirements have not been finalized and closure decisions are not expected in the near term. Some of the older single-shell tanks, with single carbon steel liners, are nearly 60 years old. Waste retrieval and tank closure schedules are likely to be extended even further into the future because of the shortage of storage space in the newer, double-shell tanks, and because of recent delays in the tank waste disposal program. In addition, there are a myriad of regulatory, programmatic, and technical uncertainties and issues that will require resolution prior to tank closure. Agreement on future land use scenarios for tank farm closure evaluations are in progress, but work on a tank closure EIS has not yet begun.

The baseline strategy is to close the tanks and farms in place, but how much waste has to be removed and what actions need to be taken for past leaks and potential leaks during waste retrieval have not been established.

## **2.3 SAVANNAH RIVER SITE**

More than two-thirds of the total curies to be retrieved and disposed in the DOE complex are contained in the HLW at the SRS. At least 10 of the tanks have leaked and/or have cracks in the tank liners. Two tanks have been interim closed, but a new EIS is required before any further tanks can be closed. Many of the older tanks will be nearly 70 years old before planned closure. Even the newest tanks are expected to be 60 years of age before closure. One tank was cleaned out 20 years ago, but is not yet closed. Several more tanks are expected to be cleaned out in the near future, but closure dates are uncertain. And, like at the Hanford Site, there are regulatory, programmatic, and technical issues surrounding final closure that will be addressed in the new EIS.

The baseline strategy is to close the tanks in place after stabilizing the tanks and any residual waste with grout.

## **2.4 IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY**

Liquid HLW was removed from the INEEL tanks and calcined in 1998. Contaminated, sodium-bearing, liquid waste remains in the tanks at INEEL. The waste is in acidic form (little sludge) in 11 stainless steel tanks, awaiting a final disposal process. While the proposed path for disposal of the HLW is well defined, tank closure requirements and approvals are not yet finalized. Tank closure plans do address 'operational or interim closure' as a DOE/*Resource Conservation and Recovery Act of 1976* action on the path to final closure.

The baseline strategy is to close the tanks and farm in place after filling the tanks and ancillary piping with grout.

## **2.5 OAK RIDGE RESERVATION**

The waste in the tanks at ORR, though physically, chemically, and radiologically similar to HLW at other sites, is not classified as HLW. Consolidation of all waste into the higher integrity tanks is well underway, and a Record of Decision is expected shortly that will allow interim closure of tanks by filling with a removable grout. All tanks without secondary containment are expected to be closed in the next 20 years and the remaining tanks within 30 years.

The baseline closure strategy is to clean out all tanks to meet waste acceptance criteria, then fill the tanks with grout.

## **3.0 PRELIMINARY NEEDS ASSESSMENT RESULTS**

One of the initial products from FY 2001 work in support of WVDP was a list of the tank lay-up requirements and considerations. This list was evolved for each of the other tank sites, considering site-specific factors. The results are shown in Table 2.

There appear to be many Hanford Site and SRS HLW tanks that have potential lay-up periods in excess of 20 years, suggesting a higher potential need for lay-up planning at these two sites. Conversely, execution of the INEEL and ORR tank retrieval and closure programs appears more near-term and better defined, although tank lay-up considerations apply to these sites as well. One measure of the complexity of tank lay-up and closure is the number of significant issues that must be addressed. For this reason, potential site lay-up issues have been included in the table.

There is not a straight-forward regulatory path for tank lay-up. Lay-up actions may require regulatory approval, although regulatory requirements during lay-up are expected to be less restrictive than for normal operation. Examples of baseline documentation potentially impacted by lay-up considerations include operating specifications, technical safety requirements, safety analyses reports, and operating procedures. Depending on the regulatory framework, lay-up options may vary significantly between sites, and even between tanks at the same site. A site-specific and tank-specific evaluation process should be developed for the tanks as they reach the end of their operational life. Appropriate DOE orders, *Resource Conservation and Recovery Act of 1976* and *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* regulations, and federal facility agreements should be evaluated against the known status of the tank, then lay-up (or closure) decisions made. This evaluation should include potential renegotiation, modification, or waiver of requirements in these documents based on the tank's proposed lay-up condition. The lay-up plan must also consider the individual tank(s) within the context of the closure plans for the tank's environment (e.g., tank farm and ancillary equipment, existing and projected waste leaks, soil and groundwater properties, site meteorology, seismology).

## **3.1 HANFORD SITE**

While the path for near-term retrieving and processing tank wastes is relatively well defined, final closure of the tanks and tank sites is complicated by a myriad of challenging issues. This means that, over the next few years, an increasing number of very old, single-shell tanks will be cleaned out and will likely have to wait for a number of years before final closure. These tanks will be prime candidates for lay-up.

**Table 2. Site High-Level Waste Lay-Up Requirements and Considerations (2 Sheets)**

<b>Requirements, Considerations, and Potential Issues</b>		<b>WVDP</b>	<b>Hanford Site</b>	<b>SRS</b>	<b>INEEL</b>	<b>ORR</b>
<b>Requirements</b>	Ensure acceptable risks to workers and public	Establish safe operating envelope during lay-up. Maintain tank integrity. Prevent leaks to groundwater.	Minimize leaks to ground, air emissions. Maintain tank integrity. Minimize liquid ingress to tank.	Minimize leaks to soil, groundwater, air emissions. Maintain tank integrity. Minimize liquid ingress to tank.	Treat tank and vault exhausts as necessary.	Store old and currently generated waste in highest integrity tanks.
	Comply with regulations, permits, and agreements	Table 1 regulatory drivers, plus DOE letter with Class C limits on tank cleanout.	Table 1 regulatory drivers, plus authorization basis, closure EIS, incidental waste determination.	Table 1 regulatory drivers, plus new tank closure EIS, incidental waste determination, impact of NRDC lawsuit (DOE O 435.1), land use implementation.	Table 1 regulatory drivers.	Table 1 regulatory drivers.
	Preserve future tank closure options	Preserve future options for tank decontamination and closure.	Consider the potential for secondary waste retrieval, remediation of contaminated soils, and remediation of ancillary equipment.	No tank closures until approval of new EIS.	Tank closure criteria awaiting DOE/RCRA documentation.	Tank closures awaiting ROD and resolution of heel technical issues.
<b>Considerations</b>	Control life-cycle costs	Control capital and operating costs. Reduce tank surveillance and monitoring.	Reduce surveillance, monitoring, and maintenance requirements during lay-up period.	Reduce surveillance, monitoring, and maintenance requirements during lay-up period.	Utilize existing systems to greatest extent possible. Leave equipment in tanks when possible.	Close inactive tanks as soon as possible after waste acceptance criteria is satisfied.
	Gain stakeholder acceptance/consensus	Involve key decision makers and stakeholders in planning/approval process.	Involve key decision makers and stakeholders in planning/approval process.	Involve key decision makers and stakeholders in planning/approval process.	Involve key decision makers and stakeholders in planning/approval process.	Involve key decision makers and stakeholders in planning/approval process.
	Minimize secondary wastes	Ensure secondary wastes can be readily disposed.	Use existing waste for retrieval. Dispose secondary wastes.	Ensure secondary wastes can be readily disposed.	Ensure secondary wastes can be readily disposed.	Ensure secondary wastes can be readily disposed.
	Use proven and accepted technologies	Include demonstrated construction methods.	Full-scale demonstration of retrieval technologies.	Modify techniques used to interim close two tanks.	Washball system to be used for cleanout.	Modify solids removal methods from other sites.

**Table 2. Site High-Level Waste Lay-Up Requirements and Considerations (2 Sheets)**

<b>Requirements, Considerations, and Potential Issues</b>		<b>WVDP</b>	<b>Hanford Site</b>	<b>SRS</b>	<b>INEEL</b>	<b>ORR</b>
<b>Potential Issues</b>	Specific to site	Ability to keep tank external surfaces dry. Ability to control oxygen (corrosion) in tanks. Effectiveness of groundwater barriers.	Dome loading, liner integrity analysis, leak detection; waste heel characterization/ inventory and classification; tank isolation, barriers; tank atmosphere control; retrieval performance; groundwater/vadose zone modeling, assessment; future land use.	Liner cracks; waste in annuli; waste in groundwater; ingress of groundwater into tanks.	Ability to demonstrate clean closure of tanks; in tank equipment; contaminated soil; source terms, groundwater modeling; future land use requirements.	Groundwater leaks into tanks; resin beads in the bottoms of some tanks.

DOE = U.S. Department of Energy.

EIS = environmental impact statement.

INEEL = Idaho National Engineering and Environmental Laboratory.

NRDC = National Resources Defense Council.

ORR = Oak Ridge Reservation.

RCRA = *Resource Conservation and Recovery Act of 1976*.

ROD = Record of Decision.

SRS = Savannah River Site.

WVDP = West Valley Demonstration Project.

### **3.2 SAVANNAH RIVER SITE**

While the SRS has demonstrated interim closure on two tanks, future progress is clouded by the requirement for a new EIS before any further closure actions can be taken. These closure uncertainties, fueled by a relatively aggressive waste retrieval schedule, provide a good environment for considering lay-up.

### **3.3 IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY**

Because of the relatively small amount of HLW remaining to be retrieved from a few nonleaking, stainless steel tanks, there is currently a diminished need for extensive lay-up planning at the site. However, because current closure plans are still not approved, INEEL could benefit from involvement in the lay-up planning process and from the results of a detailed evaluation of one tank at another site.

### **3.4 OAK RIDGE RESERVATION**

More than half of the ORR tanks are already grouted, awaiting a Record of Decision that would allow them to be closed in-place without further action. Because of this and the fact that closure actions are not complicated by HLW considerations, the need for lay-up planning appears low. However, judicious and complete closure planning may require consideration of possible delays in the closure program, and ORR could benefit from involvement in the lay-up planning process.

## **4.0 RECOMMENDATIONS**

The dialogue on tank lay-up needs to be expanded to the sites that are potentially most affected. This preliminary evaluation report is one vehicle for stimulating that dialogue and could be reviewed informally with the sites. This should include a review of the list of requirements and considerations for comprehensiveness. In parallel, this tank lay-up effort should be coordinated with the next Tank Closure Workshop, which may be scheduled sometime later in calendar year 2001. Interest and support at this workshop could greatly enhance the likelihood of involving subject matter experts at the key sites later on.

Selection of a path forward for this initiative will be made once the Tank Focus Area Strategic Initiative Review Board issues its recommendations. If it is decided to pursue a detailed lay-up evaluation for one tank, technical, programmatic, and regulatory issues should be developed as well. Candidates include tanks AX-104 and C-106 at the Hanford Site and tank 16 at the SRS. The success of this process will be highly dependent on the degree of interest and the commitment of subject matter experts at the selected site.

The tank lay-up evaluation process would include the following steps:

- Identify tank lay-up requirements and considerations
- Identify potential lay-up strategies
- Identify potential lay-up technologies
- Identify potential uncertainties and issues
- Configure lay-up alternatives for evaluation
- Evaluate lay-up alternatives using a weighted decision matrix.

This process will lead to a technically-defensible lay-up strategy for that one tank. The results of this evaluation can be applied generically by the other sites to tailor lay-up plans on an individual tank basis. Tank lay-up options resulting from this process would include the following:

- Continued operation of the tank in the same manner as before the waste was retrieved
- Wet lay-up of the tank with the addition of corrosion inhibitors
- Dry lay-up (drying the residual waste and tank atmosphere)
- Dry lay-up with the addition of a stabilizing material to the residual waste.

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